REMARKS

Claims 2 – 9 are pending in the subject application: claims 1 – 8 have been examined and stand rejected. By the above amendments claim 1 has been canceled and replace by new claim 9, and claims 2 – 8 have been amended. Favorable reconsideration of this application and allowance of the pending claims are respectfully requested in view of the above amendments and the following remarks.

Claim 1 stands rejected under 35 U.S.C. §112, second paragraph, as being indefinite. Claim 1 has been canceled, thereby rendering moot this rejection. Applicant submits that new claim 9, which replaces claim 1, meets the requirements of 35 U.S.C. §112, second paragraph.

Claims 1-8 stand rejected under 35 USC 103(a) as unpatentable over U.S. Patent No. 5,637,424 to Haruki in view of U.S. Patent No. 6,534,242 to Sugita and U.S. Patent No. 5,744,268 Nakao. Applicant respectfully traverses this rejection insofar as it may relate to claims 2-9 as amended.

New independent claim 9 sets forth a phase shift mask, comprising: first portions arranged in a pattern across the phase shift mask, the first portions having a first area, a first transmittance of electric field strength of light to be irradiated through the phase shift mask, and a first phase shift characteristic with respect to light traversing the phase shift mask through the first portions; and at least one second portion disposed adjacent the pattern of first portions across the phase shift mask, the second portion having a second area, a second transmittance of electric field strength of light to be irradiated through the phase shift mask, the second transmittance being different from the first transmittance, and a second phase shift characteristic with respect to light traversing the phase shift mask through the second portion, wherein the product of the first area and the first transmittance is substantially equal to the product of the second area and the second transmittance, such that a zero order diffraction of light is substantially absent from light irradiated through the phase shift mask.

Essentially, Applicant has discovered that the zero order diffraction of light can be substantially eliminated by selecting the areas and transmittances of the first and second portions

such that the product of the area of the first portion and its transmittance is substantially equal to the product of the area of the second portion and its transmittance, thereby permitting frequency doubling with the phase shift mask, resulting in smaller feature sizes. For example, if the first portion is substantially transparent to the incident light (i.e., a transmittance of about 100%) and the transmittance of the second portion is 50%, then the zero order diffraction of light can be substantially eliminated by making the area of the second portion twice the area of the first portion (100% x A = 50% x 2A).

As explained in Applicant's specification, phase shift masks in which different portions of the mask have different transmittances, such as required by claim 9, are conventionally known as attenuated phase-shift masks (HTPSM). Conventional attenuated phase shift masks typically include a transparent portion (transmittance of nearly 100%) and another portion with a transmittance of about 6%. However, such conventional attenuated phase shift masks do not meet the area-transmittance product requirement recited in claim 9 and are not capable of eliminating the zero order diffraction of light or achieving frequency doubling.

The effect of the claimed features relating to the condition of substantially equal products of area and transmittance is, *inter alia*, a frequency doubling of structure elements. As illustrated in Figs. 5B or 6B etc. of the subject application, this doubling occurs when this condition of equal products is fulfilled. Shown are intensity distributions in the wafer plane.

Varying the ratio of respective products leads to a case wherein side maxima 302 are enhanced until these attain similar intensities as the main maxima 301 (right hand side of Figs. 5B, 6B). If the above mentioned condition is not fulfilled, merely the main maxima 301 directly image elements from the pattern formed on the mask into the wafer plane (left had side of Figs. 5B, 6B). As a result, the resolution of periodic patterns projected onto a wafer as claimed according to the subject matter of claim 1 can be enhanced (doubled).

No combination of the cited reference discloses or suggests a phase shift mask having the area-transmittance product relationship required by claim 9. Haruki's disclosure does not even relate to attenuated phase shift masks, much less suggest the area-transmittance product

relationship recited in claim 9. Haruki describes a pattern ("unit mask") on a phase shift mask, which has first transparent portions 1 with phase shift zero and second transparent portions 2 with phase shift π. Further, portions 5 are light shielding (embodiments of Figs. 1, 4, 18, 28, etc.). The pattern shown in the figures may be disposed in a manner one upon the other in the vertical direction and further even two-dimensionally (col. 9, lines 37-41) in order to yield a periodic pattern.

A light transmission characteristic (abstract) of this pattern is changed by amending the size of a hole (portions 1 or 2) greater in one direction than in another direction (see, e.g., claim 1 of Haruki). It is noted, that the "transmission" according to Haruki does not refer to an attenuation of the transmittance, which is typically provided in terms of a percentage value (see Applicant's specification, page 11, lines 5-6). The phase shifter masks proposed in Haruki are of the Levenson, chromeless or edge emphasized type (see col. 13-15) and do not include light attenuating portions.

Moreover, Haruki does not disclose or suggest that the product of the area and transmittance of portion 1 is substantially equal to the product of the area and transmittance of portion 2. Further, no suggestion is provided whether the transmittance even differs between portions 1 and 2, as required by claim 9.

Intensity distributions resulting from the patterns in an image plane of a projection apparatus are shown, e.g., in Figs. 6, 8, 10, 12, 14 and 16 according to Haruki. The figures involve a comparison between an improvement proposed in Haruki and a conventional pattern as shown, e.g., in Fig. 5 (having square-like portions 1 or 2). The convention pattern yields intensity distributions including moderate side maxima (sub-peaks) and not to a doubling of frequency of similar main and side maxima in the image plane. Accordingly, instead of adapting the size of the portions of the pattern in order to yield side maxima similar to those of the main maxima, Haruki suppresses the former ones. Haruki thus teaches away from the present invention, even if Haruki had regarded a different amount of transmission (attenuation) between portions 1 and 2.

Nakao describes a phase shift mask, which comprises a pattern for forming fine pitch structures on a wafer, the pattern having five types of portions: (S) light shielding (Ta1) transparent substrate, (Ta2) trench in substrate, (Tn1) substrate with semi-shielding layer, (Tn2) trench in substrate with semi-shielding layer. Figs. 1-4 of Nakao disclose a proposed layout of a periodic arrangement of patterns.

Inspecting Figs. 1-4 more closely reveals the following: one cell area (4x4 portion area) within the periodic arrangement includes an amount of six unit areas with regard to portions S, one unit area with regard to portion Ta1, four unit areas with regard to portion Ta2, one unit area with regard to portion Tn1, and four unit areas with regard to portion Tn2 (together 16 unit areas). Accordingly, a first portion having full transmission (i.e., no semi shielding layer) formed from Ta1 and Tn1 has two unit areas per cell and a second portion having a reduced transmission formed from Ta2 and Tn2 has eight unit areas per cell.

Information about respective transmittance or attenuation values is provided for this embodiment of Nakao at col. 9, line 41: transmittance of the light intensity amounts to 50%. As there is a factor of four in the area size but a factor of two in transmittance, the area-transmittance products of both portions cannot be the same, and thus cannot meet the area-transmittance product requirement of claim 9.

Further evidence that the claimed features of the invention are not disclosed in Nakao is clear from inspection of the intensity distributions resulting from the proposed pattern (Figs. 19, 20). These distributions do not show any further side maxima (or sub-peaks) besides the main maxima. The purpose of the pattern proposed by Nakao with respect to a "conventional case" (contact hole pattern shown in Fig. 18, distributions in Figs. 21, 22) is an increase in peak intensity at defocus (see col. 13, lines 7-25), i.e., no frequency doubling is attempted by Nakao.

Sugita describes a method of transferring a device pattern to a resist on a wafer by means of a double exposure (abstract, Fig. 21). A first high-resolution image of the lines and spaces is achieved by means of two-beam interference (Fig. 15). A second image is laid over the first image using an ordinary exposure (Figs. 5-11). An embodiment using phase shift masks is

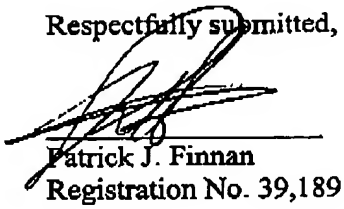
shown in Fig. 47 (see also Figs. 43-46). The high resolution image is performed by using a phase shift mask of the chromes type (Fig. 47B). A conventional light shielding mask is used to transfer the desired structure (gate pattern) to the resist (Fig. 47D). Sugita does not disclose or suggest that different portions of a pattern on one and the same mask are provided with different values of transmittance, much less the equality of the area-transmittance product of different portions, as required by claim 9.

Since none of the references discloses or suggests the aforementioned claim requirements, the subject matter of claim 9 and its dependent claims would not have been (and could not have been) obvious from any combination of these references. Consequently, the Examiner is respectfully requested to find claim 9 and its dependent claims allowable.

In view of the foregoing, Applicant respectfully requests the Examiner to find the application to be in condition for allowance with claims 2-9. However, if for any reason the Examiner feels that the application is not now in condition for allowance, the Examiner is respectfully requested to call the undersigned attorney to discuss any unresolved issues and to expedite the disposition of the application.

Applicant hereby petitions for any extension of time that may be necessary to maintain the pendency of this application. The Commissioner is hereby authorized to charge payment of any additional fees required for the above-identified application or credit any overpayment to Deposit Account No. 05-0460.

Respectfully submitted,



Patrick J. Finnan
Registration No. 39,189

EDELL, SHAPIRO & FINNAN, LLC
1901 Research Boulevard, Suite 400
Rockville, Maryland 20850-3164
(301) 424-3640
Hand Delivered on: January 11, 2006